

## Mammals of Sansan (Mammifères de Sansan)

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For palaeontologists working on the Cenozoic and on mammals, the Sansan locality represents one of the earliest mammal localities discovered in Europe and one of the richest sites in the Cenozoic. In addition it is the type locality of biozone MN6 of the European mammal biochronological time scale. This second volume dedicated to Sansan, written in French but including extended abstracts in English, is exclusively focussed on fossil mammals. It follows the publication of a first volume, edited in 2000 by the late Léonard Ginsburg, which included contributions on the historical background of the locality, its geology, stratigraphy, sedimentology, magnetostratigraphy, and non-mammalian fossils.

The book proposes an almost entire systematic revision of the mammalian fauna since the publication of Henri Filhol in 1890. The work of the editors and the 22 contributors strongly reflects a longstanding interest for mammal palaeontology. Of the 16 papers, 15 concern systematic palaeontology of specific groups and a last chapter is related to the palaeoecology and the palaeoenvironment of the locality. Only the Proboscidea, the Moschidae, and the Cervidae, also recorded at Sansan, are not included in the book, due to the lack of contributors. The complete updated descriptions of the other taxonomical groups that are present at Sansan (Chiroptera, Rodentia, Artiodactyla, Perissodactyla, Carnivora, Primates) offer a very good systematic review of the faunal spectrum. Additionally, most of the systematic papers indicate the general ecological relevance of the referred taxa. The palaeoecological analysis of the last chapter applies several

methods to the fauna and gives a very good assessment of the taxonomic diversity, including 85 species, as well as of the palaeoenvironmental context. It is not possible here to provide a detailed discussion of all contributions, and I will focus on general comments and highlight the most important results and implications of each chapter. All taxonomical groups of small mammals recorded in Sansan are presented, including relevant historical, recent references, and ecological considerations. Ginsburg and Mein give an updated faunal list of Chiroptera and Sciuridae including the most recently found fossils. Among the Sciuridae, seven species are identified including two flying squirrels (*Albanensia sansaniensis*, *Blackia miocaenica*). The diversity suggests a relatively open environment, with some tall trees where these flying squirrels lived. Maridet and Sen propose a revision of the cricetids and estimate palaeotemperatures that seemed to be equivalent to what is known today in subtropical humid climates. In the revision of the Eomyidae by Hugueneu, the morphological and biometrical data on *Keramidomys carpathicus* allow supporting a subspecific distinction between *Keramidomys carpathicus octaviae* in Sansan and *Keramidomys carpathicus carpathicus* in Neudorf (Germany). This distinction reveals biogeographical variations and regionalism between Central Europe and Southwestern France. The remains of the small-sized castorid recorded in Sansan have been ascribed to various species in the past. With their revision, Hugueneu and Duranthon assign all the available material to the species *Euroxenomys minutus minutus*.

Concerning the Lagomorpha, the newly collected material and the revision of López-Martínez considerably increases the knowledge of this group. The most frequent species is *Prolagus oeningensis sansaniensis* (388 remains out of a total of 392). However, a first upper molar and three dental remains are attributed to a second

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Ochotonidae, *Lagopsis* sp. *L. aff. verus*, and to a Leporidae gen. et sp. indet., respectively. The latter represents the oldest Leporidae from Europe, preceding by over 2 million years the next record. The three families of ruminants studied in the book, the Bovidae, the Palaeomerycidae, and the Tragulidae, are each represented by a single species. The important contribution of Van der Made exposes a major study of *Eotragus clavatus* (Bovidae), addressing not only a complete taxonomical work, but also phylogenetic, palaeobiogeographical, stratigraphical, and ecological considerations. Astibia assigns all material of Palaeomerycidae to the species cf. *Ampelomeryx magnus* comb. nov., which differs from the type species *Ampelomeryx ginsburgi* by larger dimensions, proportionally shorter premolar rows and a notably greater molarization of the p4. This attribution to the genus *Ampelomeryx* follows recent research that has assigned most of the European fossils traditionally described as *Palaeomeryx* to *Ampelomeryx*. Moreover, the type species *Palaeomeryx kaupi* has today to be considered as a *species inquirenda*. Concerning the third ruminant species, *Dorcatherium crassum* (Tragulidae), Morales et al. shed new light on the phylogenetic relationships of the European and Asian genera of Tragulidae, but a clear scheme cannot yet be put forward. The ruminant diversity recorded in Sansan is ecologically coherent, revealing a humid forested area. Pickford identifies three species of Suoidea in Sansan: *Choeromorus mamillatus*, *Conohyus sinorrensis*, and *Listriodon splendens*. Even if the systematics of mid-Miocene Suoidea is not completely resolved with this contribution, the fine description of the material from Sansan as well as the ecological and biogeographical discussions constitute an important result for the knowledge of the European Suoidea. The study of Guérin on the chalicotheriine *Anisodon grande* describes the most important presently known assemblage of the species in Western Europe. The material includes fragmentary skulls and mandibles, 28 isolated back teeth and 241 postcranial bones. Such a richness of remains allows a complete anatomical analysis, pointing out to the intra-specific variability of the species. After Guérin, *Anisodon grande* clearly indicates a dry forest environment.

The Rhinocerotidae are among the first fossil mammals of Sansan to have been described, by Edouard Lartet in 1837. As in most of the Miocene mammal localities, their remains are frequent within the large mammal fauna of Sansan. Heissig proposes a vast contribution offering for the first time a complete and detailed osteological study of the four species recorded (*Hoploaceratherium tetradactylum*, *Lartetotherium sansaniense*, *Aceratherium (Alicornops) simorreense*, and *Brachypotherium brachypus*), which are considered as a reference for comparisons in many studies. Especially, Heissig describes the lectotype for *Hoploaceratherium tetradactylum*, the dominant

rhinocerotid of Sansan. Thanks to the recent discovery of two partial skeletons, the author provides important new data that greatly improve our knowledge of the limb proportions of this species.

Based on dental and appendicular morphology, and on differences in size, Alberdi and Rodríguez phylogenetically place the anchitere of Sansan in the same lineage of *A. aurelianense aurelianense* and determine it as *Anchitherium a. hippoides*. From a palaeoecological point of view, the morphological characters of the limb extremities of *Anchitherium a. hippoides* show evidence of a running adaptation associated to more open and dry environment.

The contribution of Senut describes for the first time the rare postcranial elements of pliopithecids from Sansan, although some of them have already been cited in previous publications. The referred specimens are not very numerous, but enough diagnostic to be indicative of two groups of primates, a larger one attributed to *Pliopithecus antiquus* and a smaller one to *Plesiopliopithecus auscitanensis*. Both exhibit features adapted to arboreality. The carnivoran fauna, notably rich and diverse, is the subject of a huge contribution of more than a hundred pages by Peigné, bringing together old material and recently found specimens. The author indicates that at least 20 species are present, including 17 determined at the species level. The up-to-now unpublished material described allows identifying four new taxa unknown from Sansan so far. As the carnivoran fauna of Sansan is one of the richest for the European mid-Miocene and as the chapter of Peigné is an amazing research work, his contribution can be considered as one of the most valuable reference for the Carnivora of this period in Europe. In their ecological and environmental study of Sansan, Costeur et al. underline the good approximation of the 85 identified species. By applying several methods to the fauna to better understand the palaeoenvironmental context (cenograms, ecological histograms, transfer function, principal component analysis performed on the proportion of species in different body mass categories), the authors decipher a forested habitat in a subtropical to tropical climatic context with more open areas and swamps in a possibly seasonal climate. To sum up, the book is a solid piece of palaeontological research, covering with competence and consistence important aspects of the osteology, osteometry, systematics, stratigraphy, and ecology of mid-Miocene European mammals. It is nicely produced and illustrated, and greatly improves the knowledge of the European mammal diversity and terrestrial palaeoenvironmental context. It contains high quality chapters that are of interest for everybody working with or simply interested in European terrestrial palaeoecosystems. There are so many important and original contributions included that specialists in mammal palaeontology should own this volume.